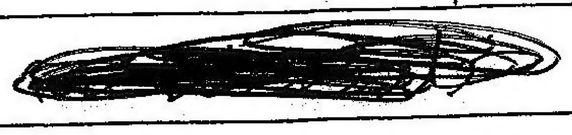
Specialization	Electrical Engineering
Course Name:	Power Electronics
Date:	24/11/2011
Time:	11:00-12:00
Instructor:	Dr. Anees Abu Sneineh

Palestinian National Authority
Ministry of Education & Higher Education
Palestine Technical University
College of Engineering & Technology
Second Exam
First Semester 2011/2012

Name: 

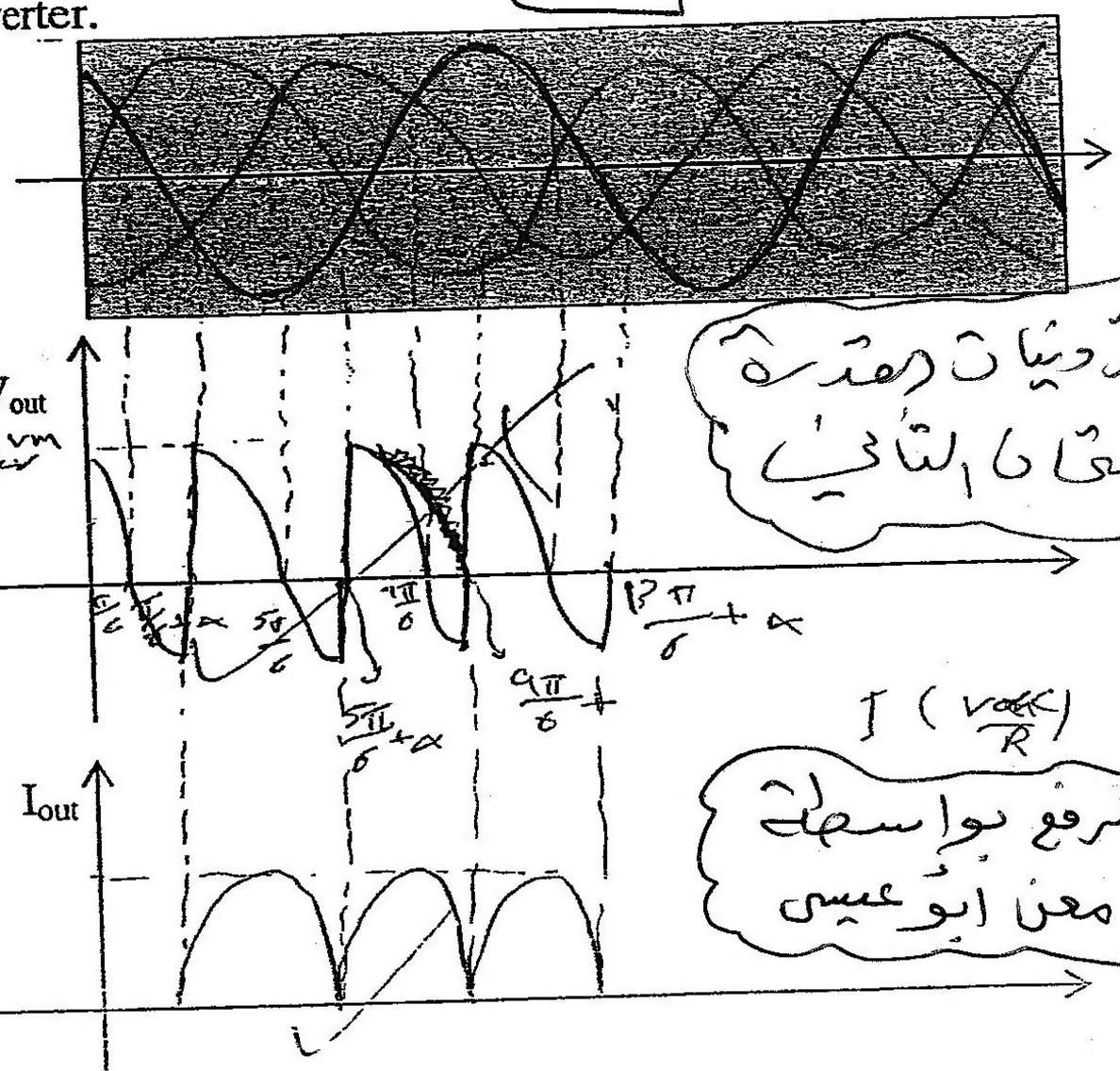
Section:

21 /25

Power Electronics 2nd Exam

Q1. For Three-Phase Half-Wave Controlled Rectifier, V_m=50V, R=4.5Ω: 21/25 **(10-marks)** Q1

a. Draw the output voltage and current waveforms for RL-load.
b. b. Draw the region of operation for this converter.
c. Find V_{dc}, V_{rms} when $\alpha = \pi/6$
d. Find FF, RF, TUF, PIV



اللهم ثبتنا وهذه الامتحان الثاني
تم الرفع بواسطة م. معن ابو عيسى

$$c = \frac{3\sqrt{3}\,V_m}{2\pi}\cos\alpha$$

$$= \frac{3\sqrt{3}*50}{2\pi}\cos\pi/6$$

$$= 35.81\ V$$

$$V_{rms} = \sqrt{3}\,V_m\sqrt{\frac{1}{6} + \frac{\sqrt{3}}{8\pi}\cos 2\alpha}$$

$$\sqrt{3}*50\sqrt{\frac{1}{6} + \frac{\sqrt{3}}{8\pi}\cos\left(\frac{2\pi}{6}\right)}$$

$$\sqrt{3}*50\sqrt{\frac{1}{6} + 0.034458}$$

$$= 38.84\ V_{dc}$$

$$FF = \frac{V_{rms}}{V_{dc}} = \frac{38.84}{35.81} = 1.085 = 108.5\%$$

$$RF = \sqrt{FF^2 - 1} = 0.42 = 42\%$$

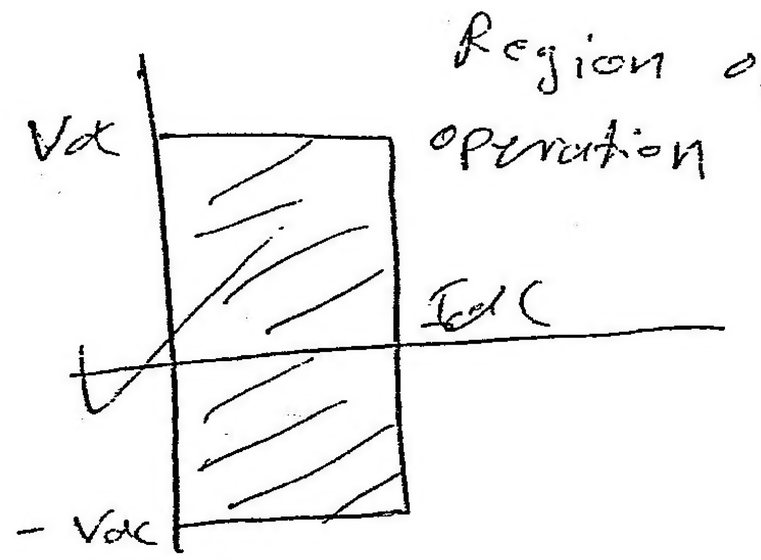
$$TUF = \frac{P_{dc}}{V_s I_{rating}}$$

$$P_{dc} = V_{dc}.I_{dc} = \frac{35.81 * 35.81}{4.5}$$

$$= 284.97\ W$$

$$V_s = \frac{V_m}{\sqrt{2}} = 35.35\ V$$

$$I_s = \frac{I_{rms}}{\sqrt{3}} = \frac{\left(\frac{V_{rms}}{R}\right)}{\sqrt{3}} = 4.951$$



Region of operation

Vdc (positive or negative)

Idc (just postive

$$P_s = V_s.I_s = 79.184$$

$$I_{dc} = \frac{128.23}{4.5} = 28.49$$

$$P_s = V_s.I_{rating} = 3.V_s.I_s$$

$$= 35.35 * 4.98 = 176.043$$

$$TUF = \frac{284.97}{176.043} = 1.619$$

$$PIV = \sqrt{3}\,V_m = 50\sqrt{3}$$

Q2. **The Input current in Fourier series for a Three-Phase Full Converter with RL-load is:**

$$i_s(t) = \frac{\sqrt{2}I_a}{\pi} + \sum_{n=1,3,5...}^{\infty} \frac{4I_a}{n\pi} \sin\frac{n\pi}{2}[\cos(n\alpha)\sin(n\omega t) - \sin(n\alpha)\cos(n\omega t)]$$

(3-marks) (3)

When $\alpha=\pi/3$, $\mathbf{I_s=I_a}$, and **DF=1**. Find the Harmonic factor and the Input Power factor.

$= I_a$

$$HF = \sqrt{\left(\frac{I_s}{I_{s1}}\right)^2 - 1}$$

$$= \frac{\sqrt{2}I_a}{\pi} + \frac{4I_a}{\pi} \sin\frac{\pi}{2}\left[\cos\left(\frac{\pi}{3}\right)\sin\left(\frac{\pi}{3}\right) - \sin\left(\frac{\pi}{3}\right)\cos\left(\frac{\pi}{3}\right)\right]$$

$$= \frac{\sqrt{2}I_a}{\pi} + \frac{4I_a}{\sqrt{2}\pi} - \frac{4I_a}{\sqrt{2}\pi}$$

$$HF = \sqrt{\left(\frac{I_a}{\frac{4I_a}{\sqrt{2}\pi}}\right)^2 - 1} = 0.47$$

$$PF = \frac{I_{s1}}{I_s} \cdot \cos\phi$$

$$= \frac{I_{s1}}{I_s}$$

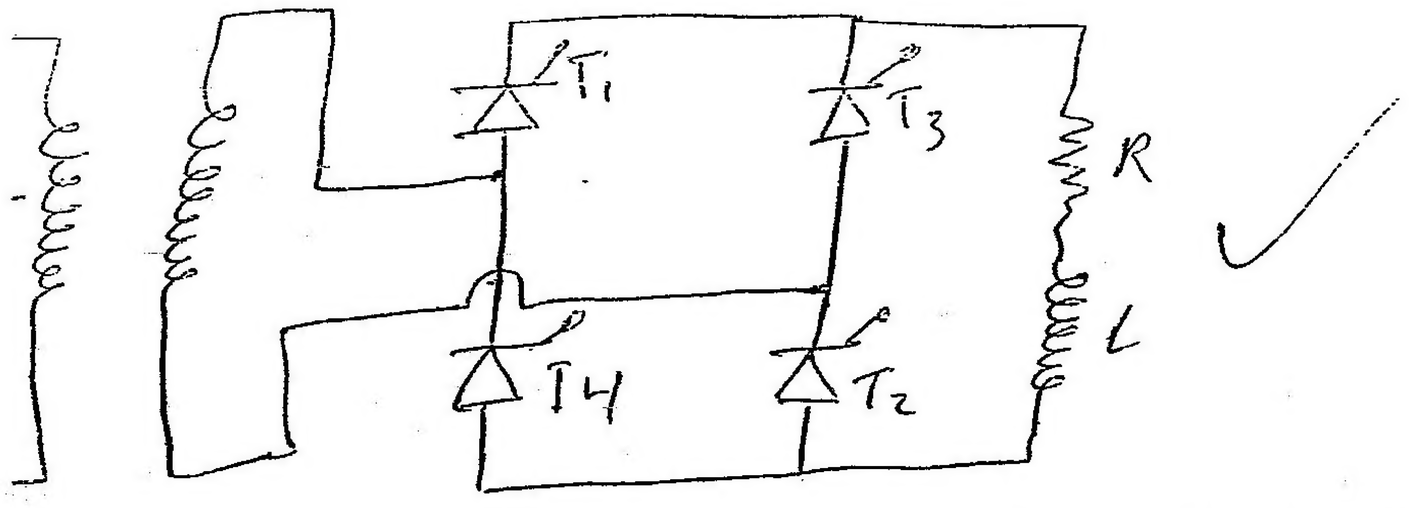
$$= \frac{4}{\sqrt{2}\pi}$$

$$= 0.9003$$

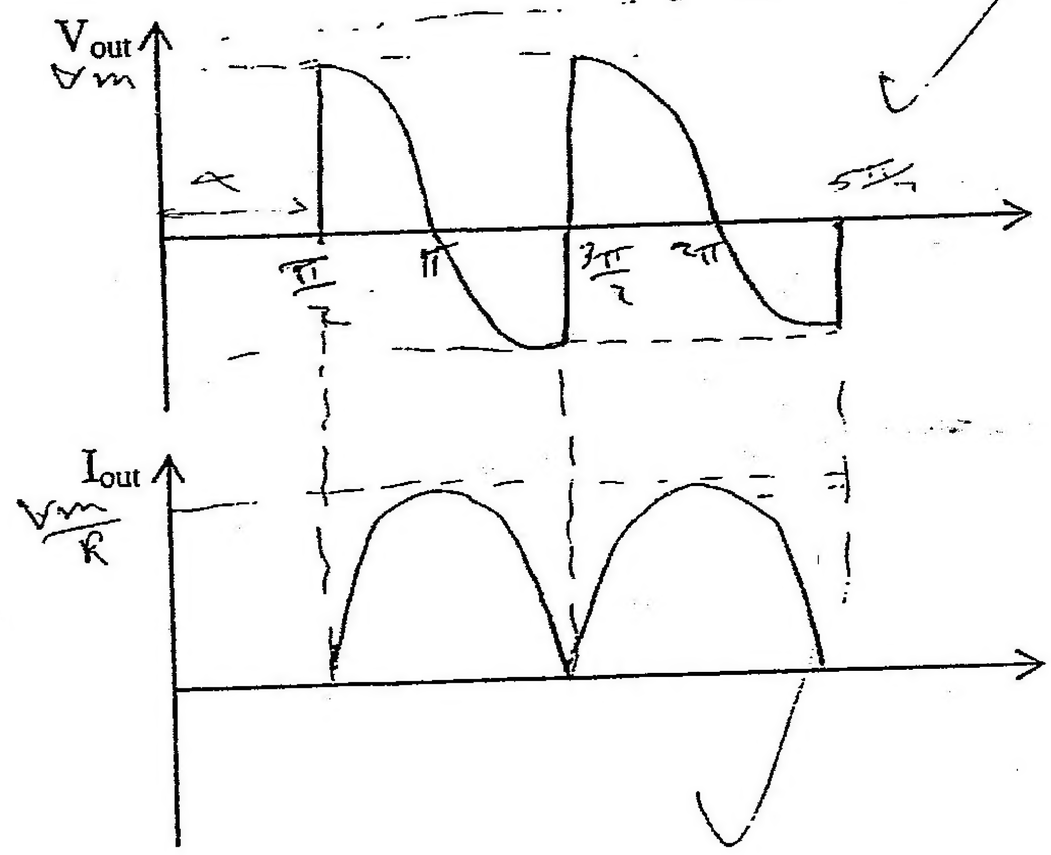
$$PF = \frac{I_{s1}}{I_s}\cos\phi = \frac{4I_a}{\sqrt{2}\pi} \cdot \frac{1}{I_a}$$

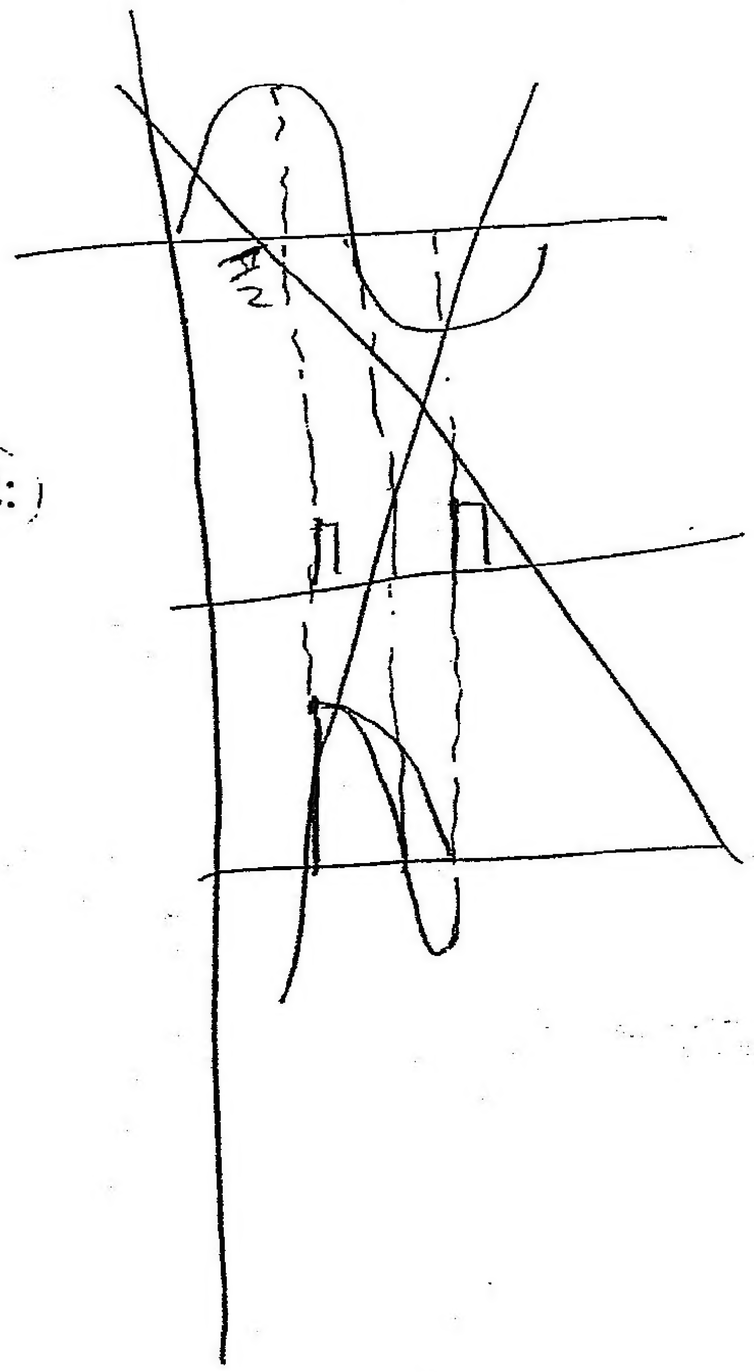
Q3. **For a single-phase Bridge Controlled Rectifier:** (3-marks) (3)

a. Draw the power circuit of this rectifier with RL-load.



b. Draw the waveforms of output voltage and current for RL-load with ($\alpha=\pi/2$:

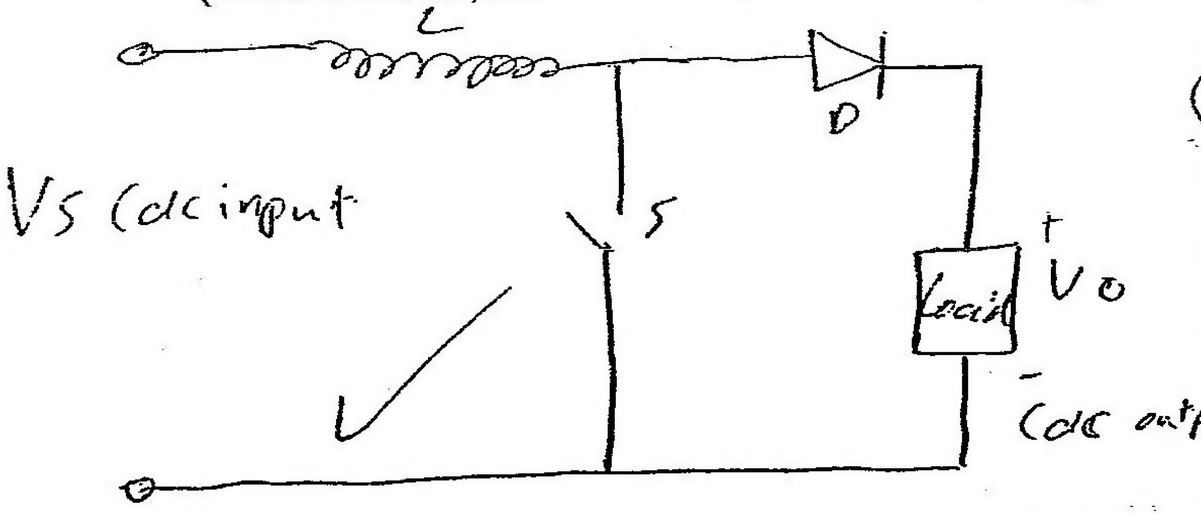




(load)

Q4. Explain the principle of operation of step-up Chopper: **(6-marks)** (4)

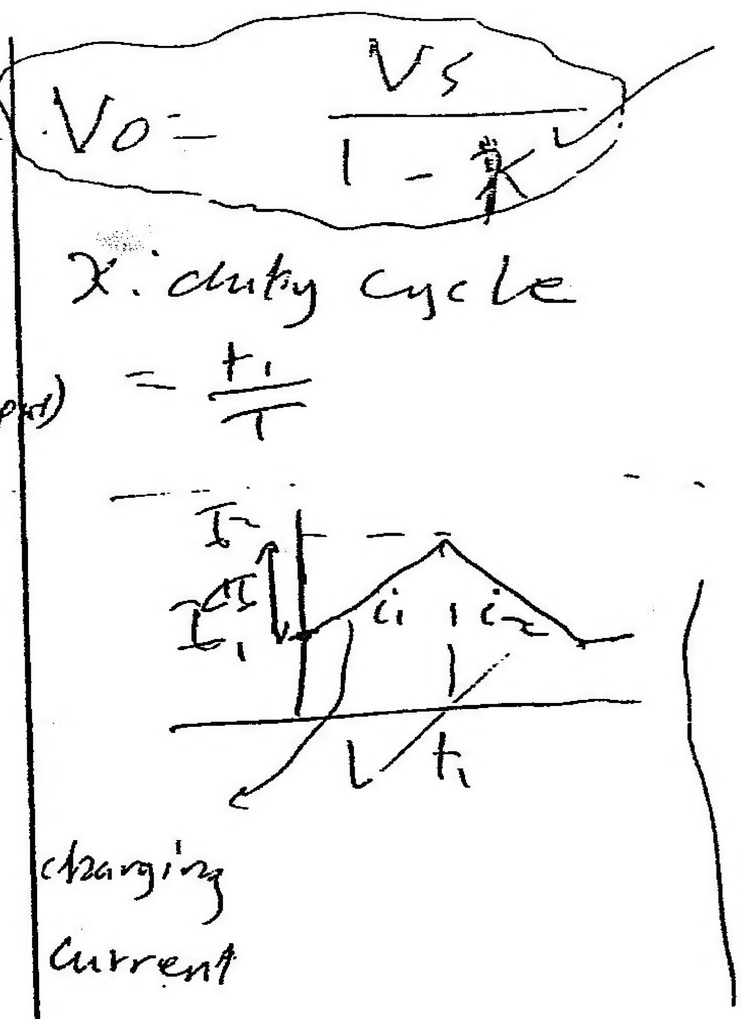
(Draw a circuit, How it works, waveforms (voltage and current), and explain the equation of output voltage)

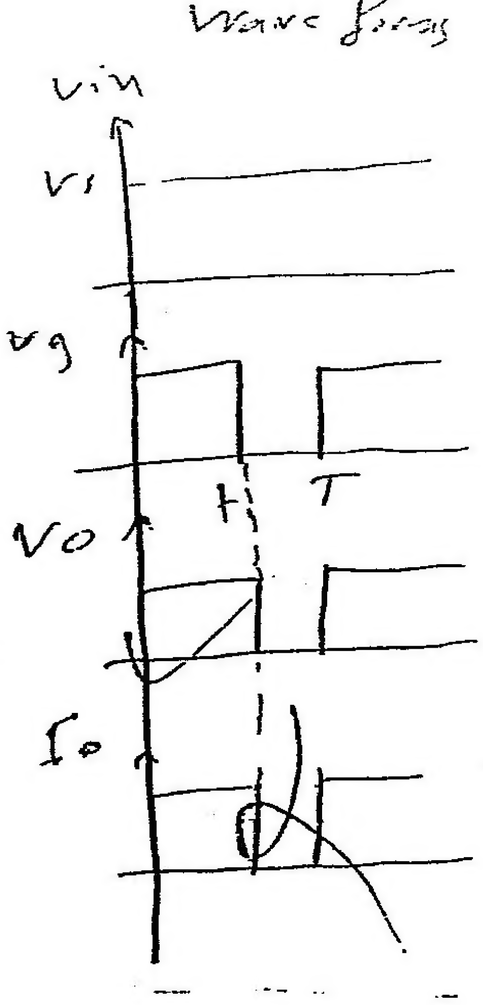


$$V_o = \frac{V_s}{1 - K}$$

K: duty cycle

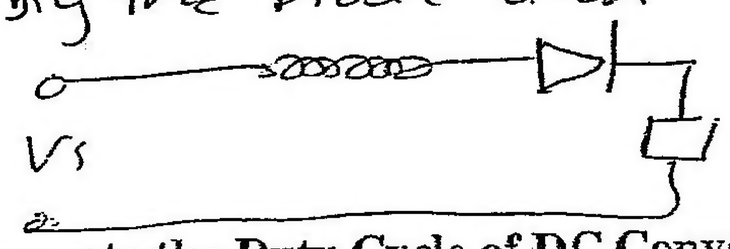
$= \frac{t_1}{T}$





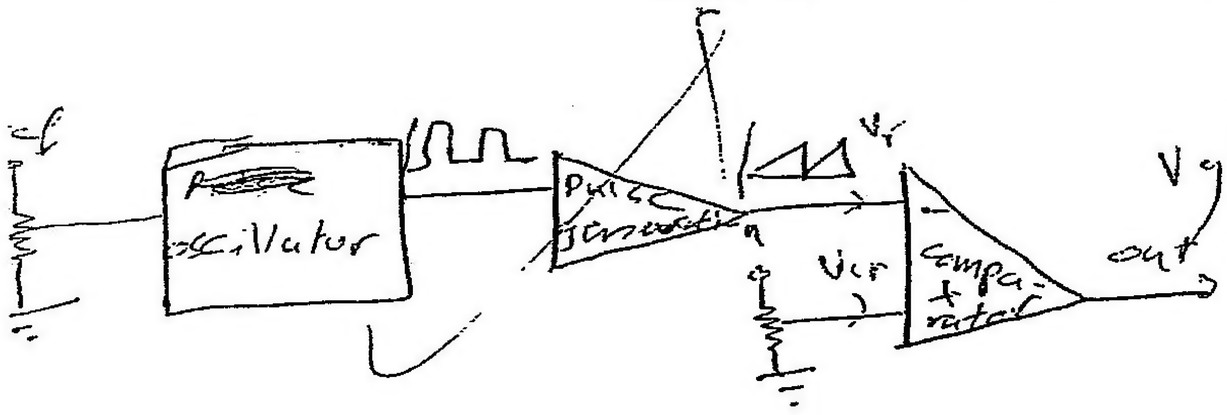
then switch is closed current ass the inductor through the witch

ren the switch is closed (mode2) rrent pass through the Diode and ad

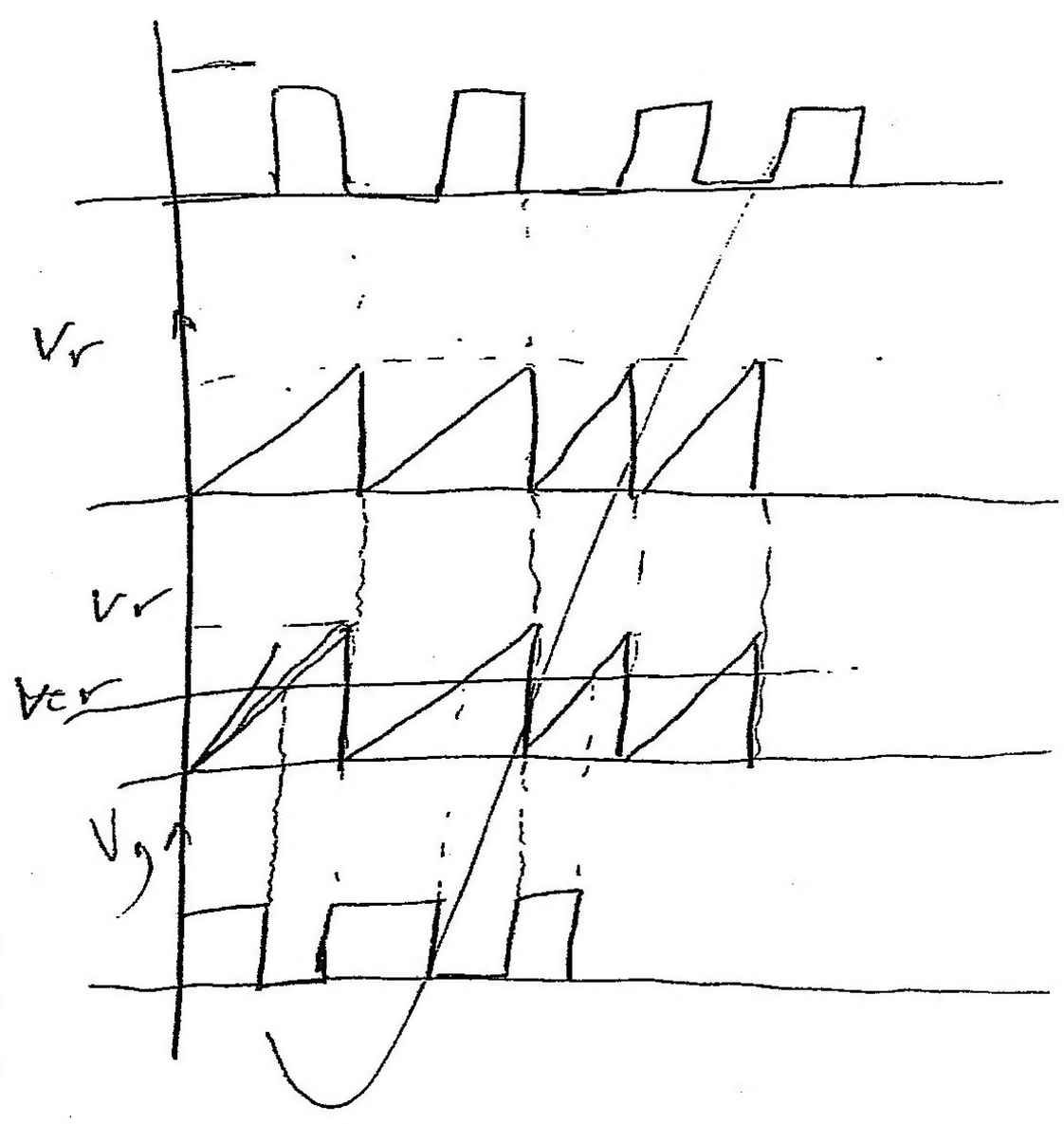


Q5. How to Generate the Duty Cycle of DC Converter: **(3-marks)** (2.5)

Show the Circuit and the Waveforms then explain them



e use the ossillator to have pulse wave form and the pass through apulse generation hen to comparator to compare he signal with carrier voltage ignal (Vr (reference voltage with cr (carier Ref voltage) e ~~the~~ Vr < Vcr (on time) Vr > Vcr (off time



Best Wishes

Dr. Anees Abu Sneineh